FIG. 1

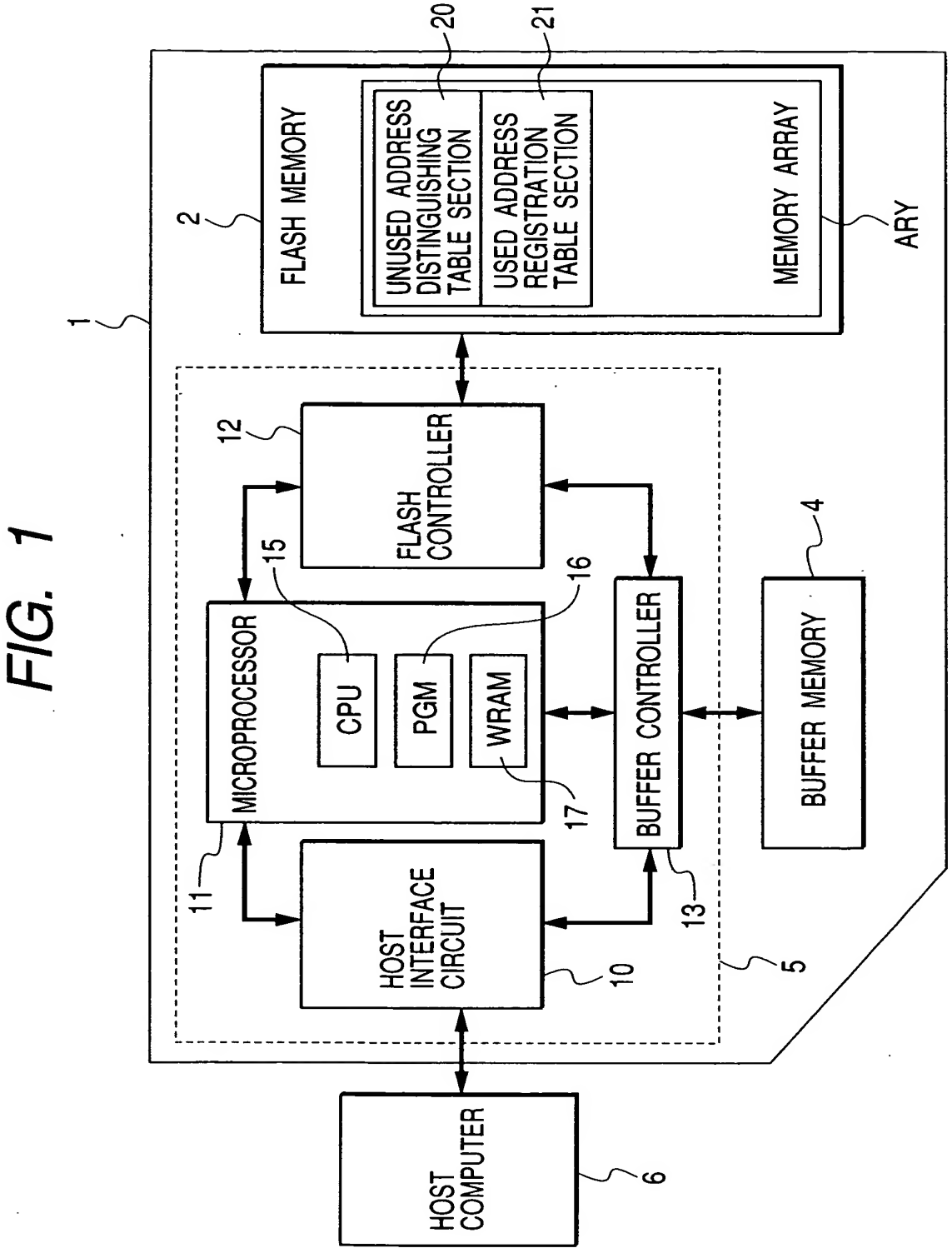

1
2
FLASH MEMORY
20
21
UNUSED ADDRESS DISTINGUISHING TABLE SECTION
USED ADDRESS REGISTRATION TABLE SECTION
MEMORY ARRAY
ARY
12
FLASH CONTROLLER
15
16
MICROPROCESSOR
CPU
PGM
WRAM
17
BUFFER CONTROLLER
4
BUFFER MEMORY
11
HOST INTERFACE CIRCUIT
10
13
5
HOST COMPUTER
6

FIG. 2

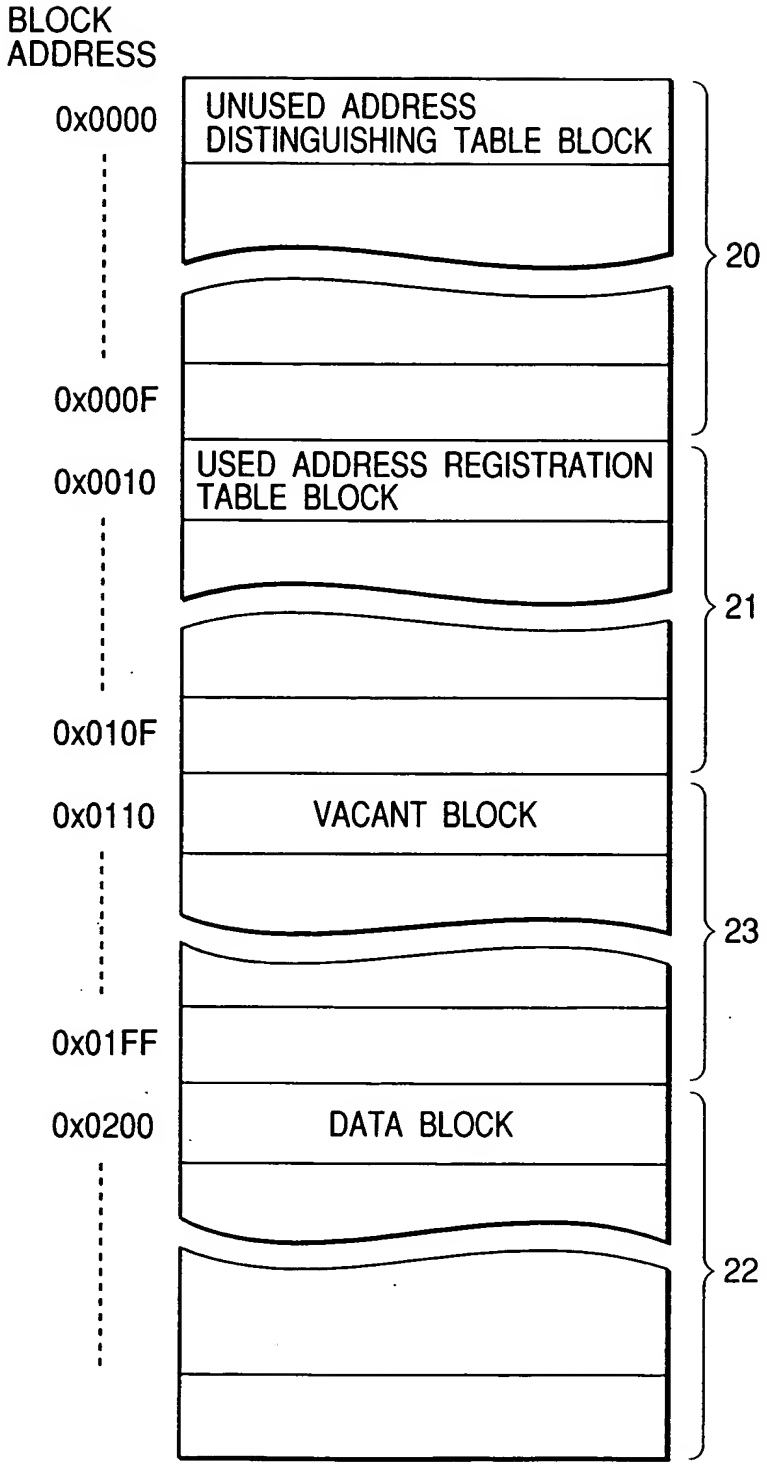

BLOCK ADDRESS
0x0000
UNUSED ADDRESS DISTINGUISHING TABLE BLOCK
0x000F
20
0x0010
USED ADDRESS REGISTRATION TABLE BLOCK
0x010F
21
0x0110
VACANT BLOCK
0x01FF
23
0x0200
DATA BLOCK
22

FIG. 3

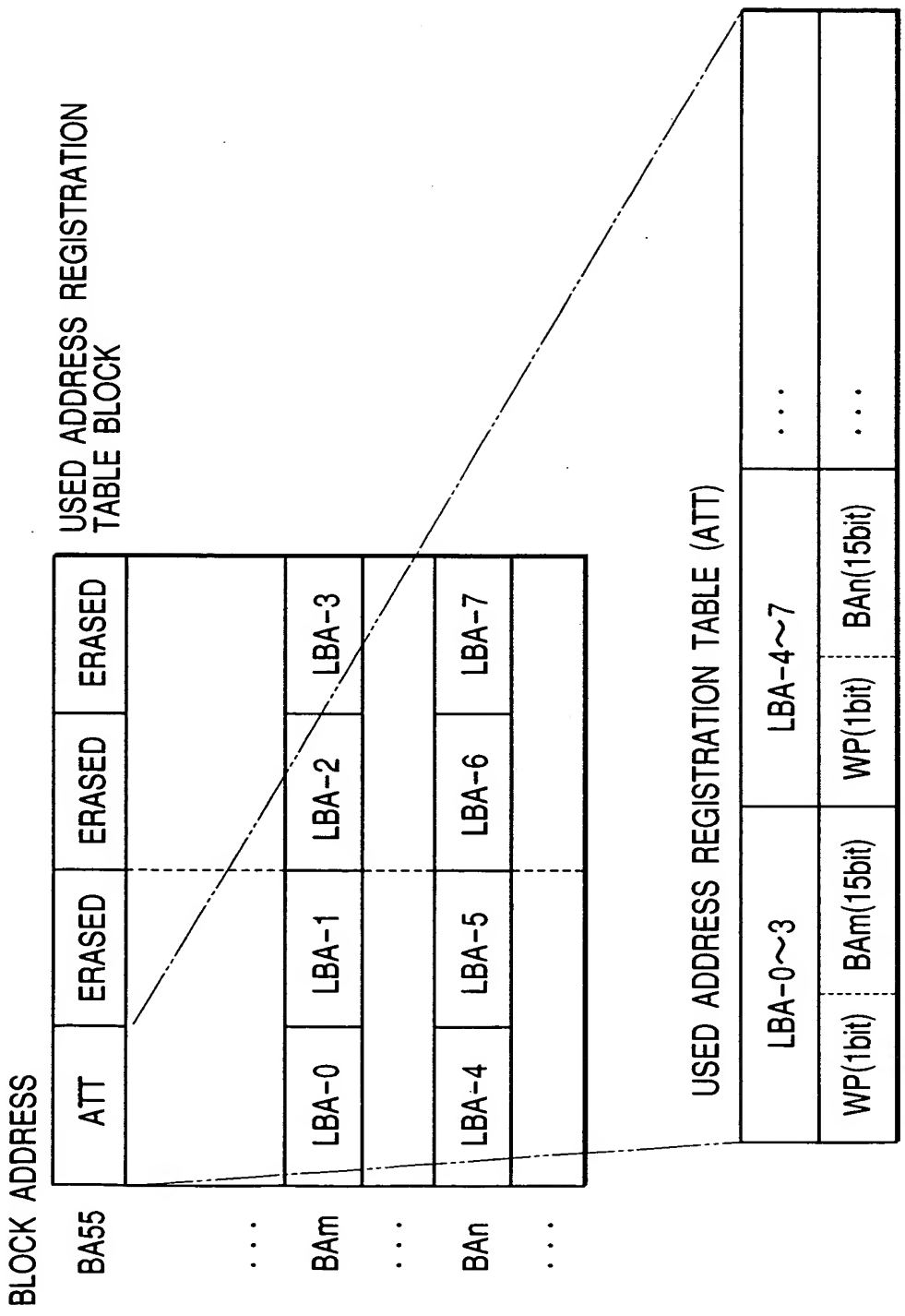

BLOCK ADDRESS
BA55
ATT
ERASED
ERASED
ERASED
USED ADDRESS REGISTRATION TABLE BLOCK
BAm
LBA-0
LBA-1
LBA-2
LBA-3
BAn
LBA-4
LBA-5
LBA-6
LBA-7
USED ADDRESS REGISTRATION TABLE (ATT)
LBA-0~3
LBA-4~7
WP(1bit)
BAm(15bit)
WP(1bit)
BAn(15bit)

FIG. 4

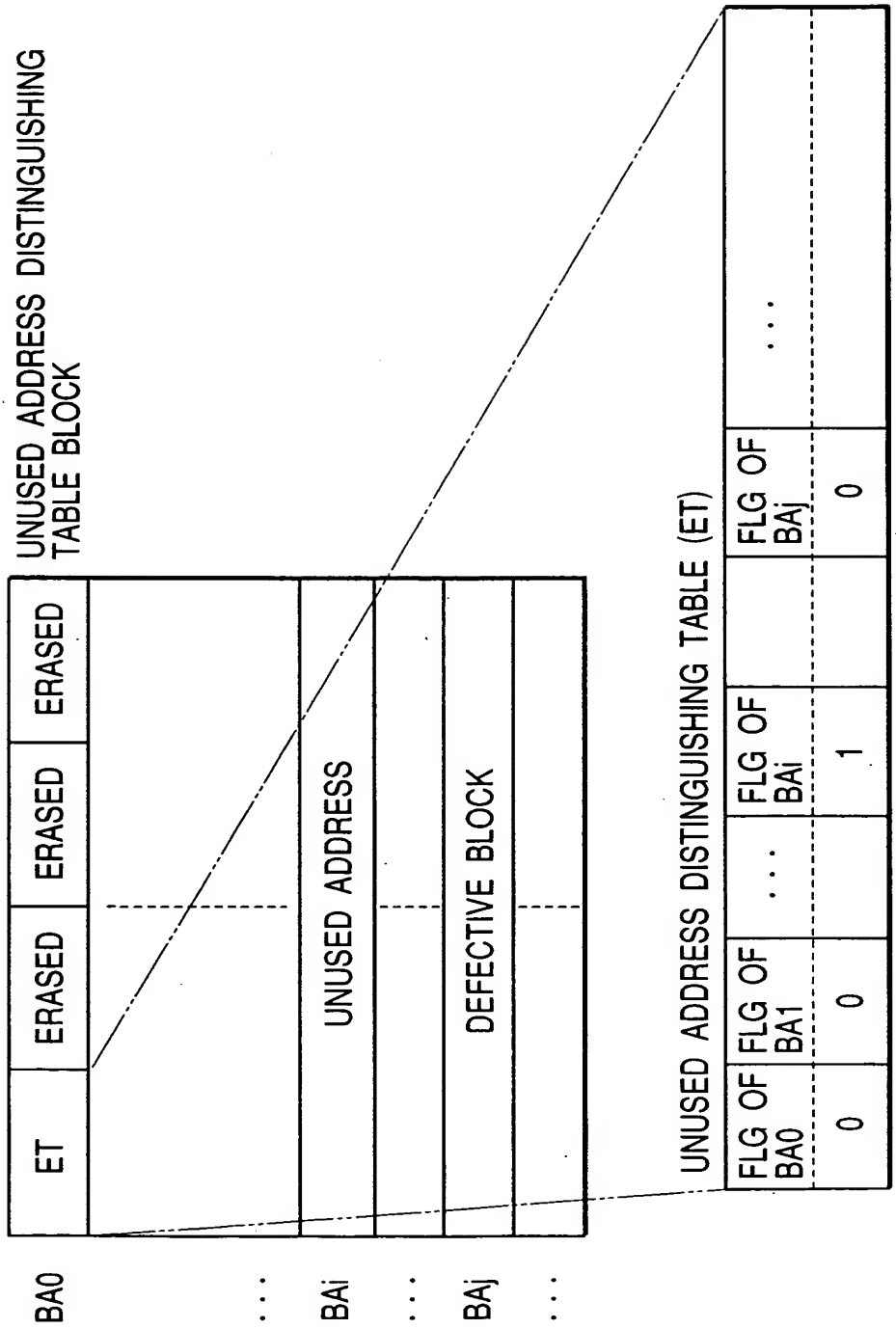

UNUSED ADDRESS DISTINGUISHING TABLE BLOCK
ET
ERASED
ERASED
ERASED
UNUSED ADDRESS
DEFECTIVE BLOCK
BA0
BAi
BAj
UNUSED ADDRESS DISTINGUISHING TABLE (ET)
FLG OF BA0
FLG OF BA1
FLG OF BAi
FLG OF BAj
0
0
1
0

FIG. 5

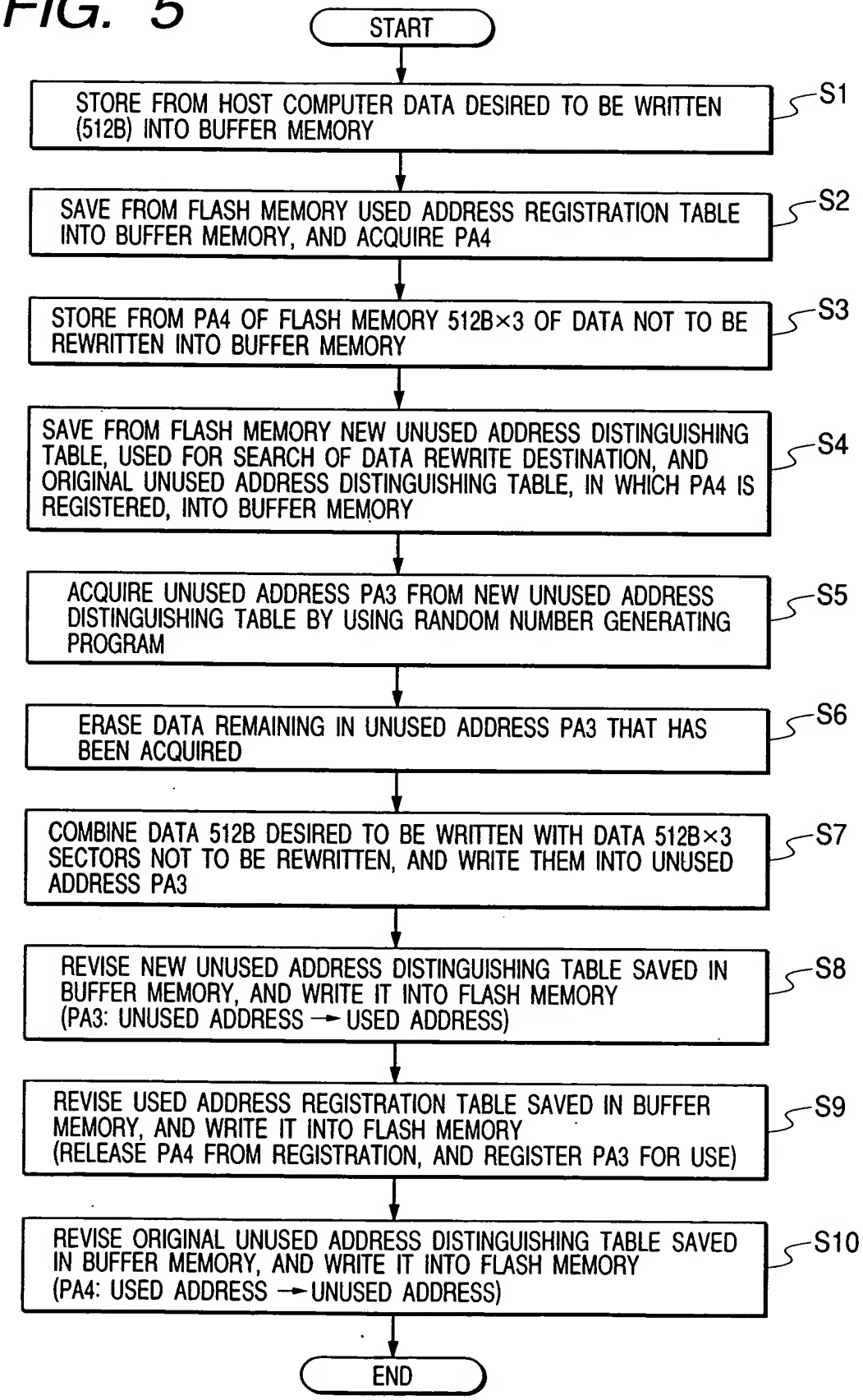

START
STORE FROM HOST COMPUTER DATA DESIRED TO BE WRITTEN (512B) INTO BUFFER MEMORY
S1
SAVE FROM FLASH MEMORY USED ADDRESS REGISTRATION TABLE INTO BUFFER MEMORY, AND ACQUIRE PA4
S2
STORE FROM PA4 OF FLASH MEMORY 512B×3 OF DATA NOT TO BE REWRITTEN INTO BUFFER MEMORY
S3
SAVE FROM FLASH MEMORY NEW UNUSED ADDRESS DISTINGUISHING TABLE, USED FOR SEARCH OF DATA REWRITE DESTINATION, AND ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE, IN WHICH PA4 IS REGISTERED, INTO BUFFER MEMORY
S4
ACQUIRE UNUSED ADDRESS PA3 FROM NEW UNUSED ADDRESS DISTINGUISHING TABLE BY USING RANDOM NUMBER GENERATING PROGRAM
S5
ERASE DATA REMAINING IN UNUSED ADDRESS PA3 THAT HAS BEEN ACQUIRED
S6
COMBINE DATA 512B DESIRED TO BE WRITTEN WITH DATA 512B×3 SECTORS NOT TO BE REWRITTEN, AND WRITE THEM INTO UNUSED ADDRESS PA3
S7
REVISE NEW UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA3: UNUSED ADDRESS → USED ADDRESS)
S8
REVISE USED ADDRESS REGISTRATION TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (RELEASE PA4 FROM REGISTRATION, AND REGISTER PA3 FOR USE)
S9
REVISE ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA4: USED ADDRESS → UNUSED ADDRESS)
S10
END

FIG. 6

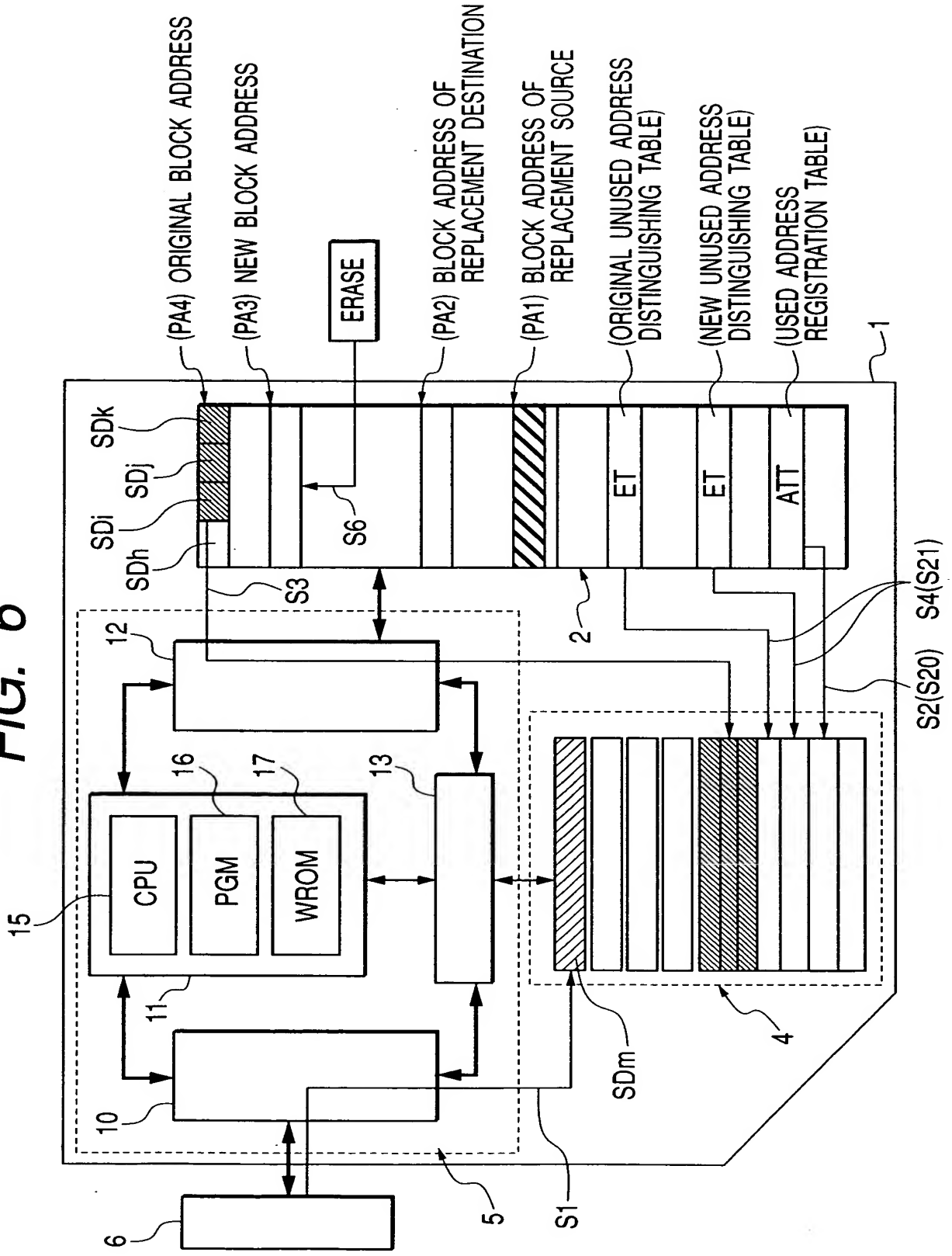

(PA4) ORIGINAL BLOCK ADDRESS
(PA3) NEW BLOCK ADDRESS
ERASE
(PA2) BLOCK ADDRESS OF REPLACEMENT DESTINATION
(PA1) BLOCK ADDRESS OF REPLACEMENT SOURCE
(ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE)
(NEW UNUSED ADDRESS DISTINGUISHING TABLE)
(USED ADDRESS REGISTRATION TABLE)
1
SDk
SDj
SDi
SDh
S3
S6
ET
ET
ATT
2
S4(S21)
S2(S20)
12
16
17
13
CPU
PGM
WROM
15
11
10
SDm
4
5
S1
6

FIG. 7

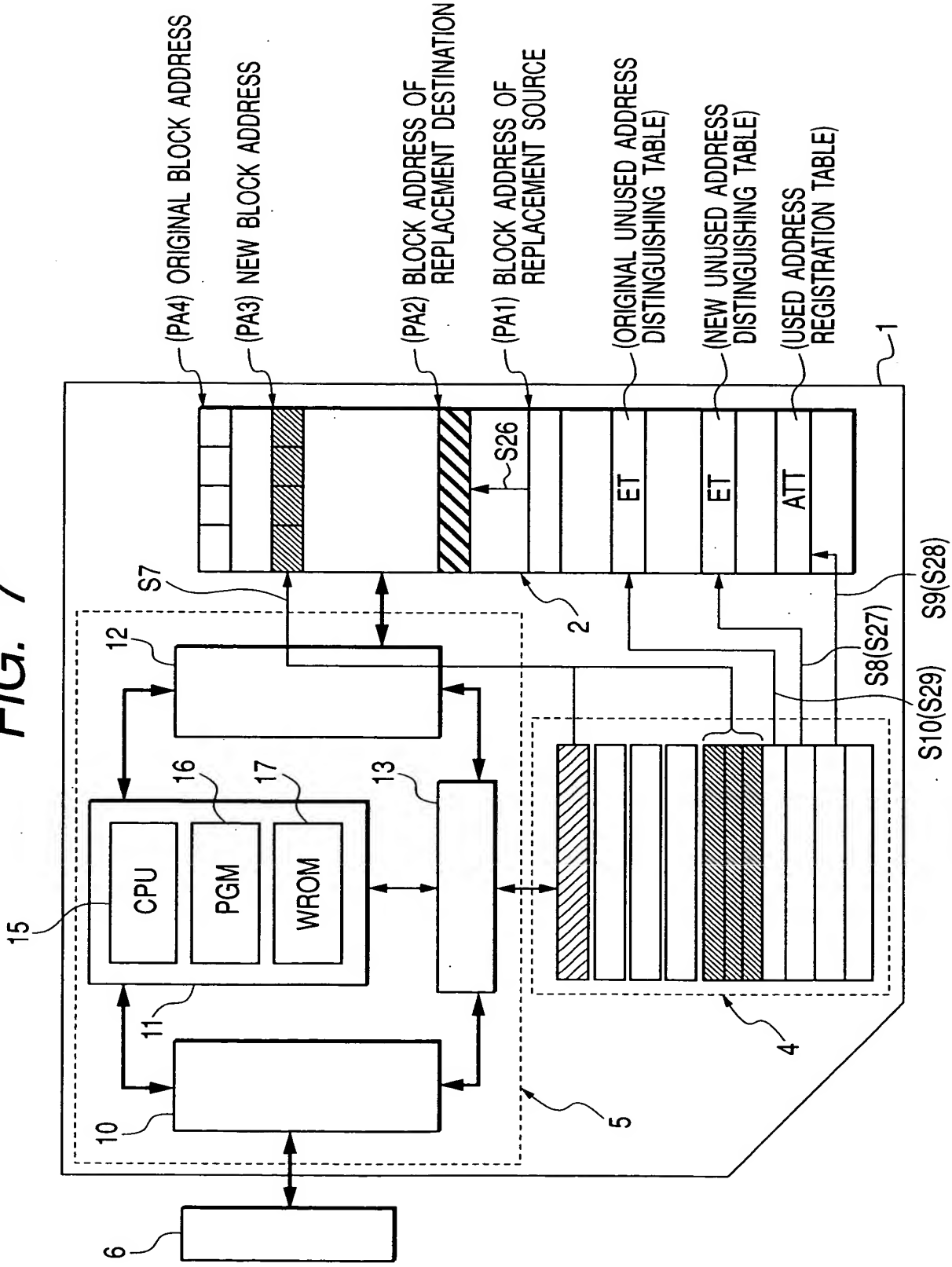

(PA4) ORIGINAL BLOCK ADDRESS
(PA3) NEW BLOCK ADDRESS
(PA2) BLOCK ADDRESS OF REPLACEMENT DESTINATION
(PA1) BLOCK ADDRESS OF REPLACEMENT SOURCE
(ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE)
(NEW UNUSED ADDRESS DISTINGUISHING TABLE)
(USED ADDRESS REGISTRATION TABLE)
1
S26
ET
ET
ATT
S7
2
S9(S28)
S8(S27)
S10(S29)
12
16
17
13
CPU
PGM
WROM
15
11
10
5
4
6

FIG. 8

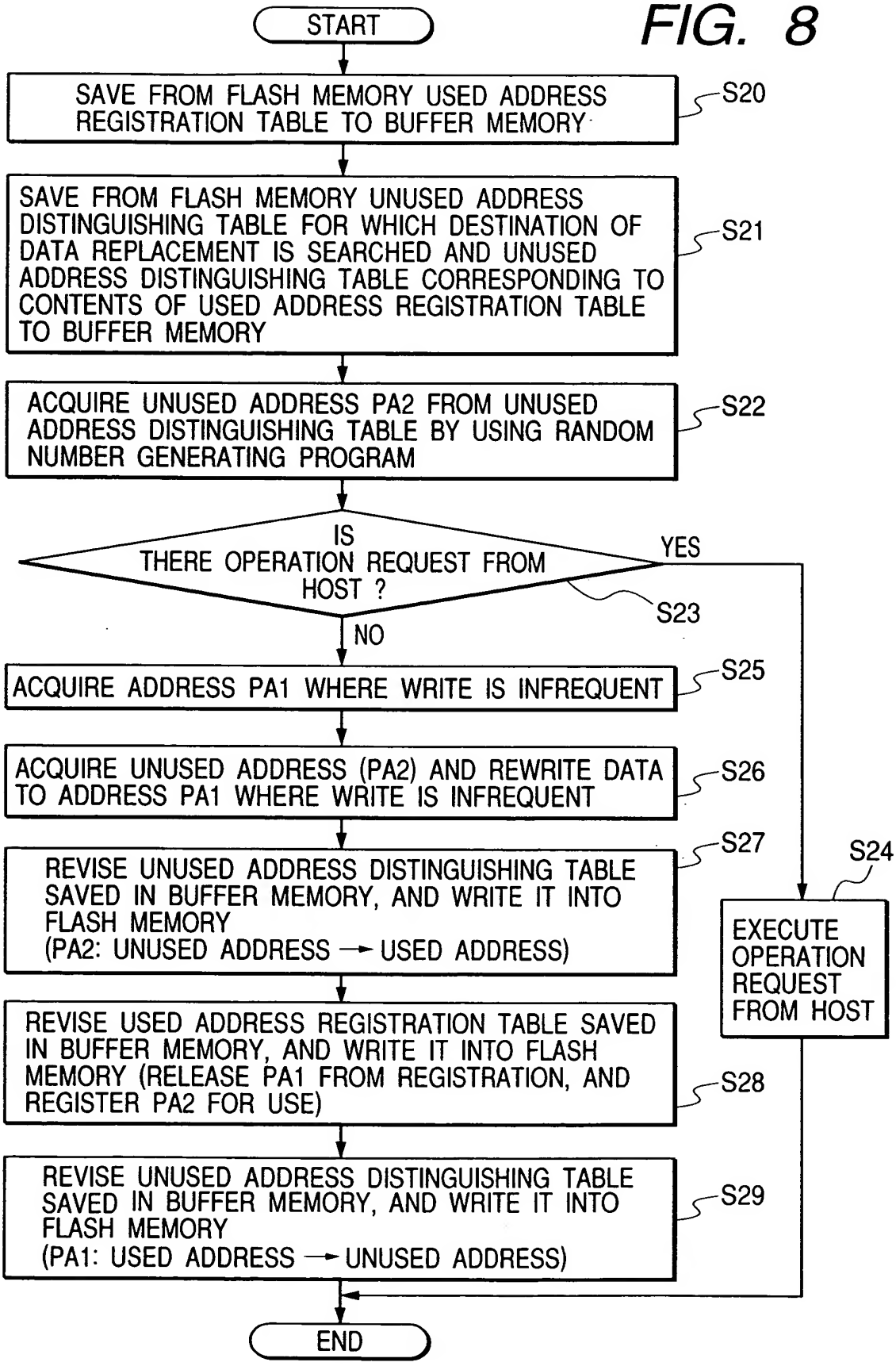

START
SAVE FROM FLASH MEMORY USED ADDRESS REGISTRATION TABLE TO BUFFER MEMORY
S20
SAVE FROM FLASH MEMORY UNUSED ADDRESS DISTINGUISHING TABLE FOR WHICH DESTINATION OF DATA REPLACEMENT IS SEARCHED AND UNUSED ADDRESS DISTINGUISHING TABLE CORRESPONDING TO CONTENTS OF USED ADDRESS REGISTRATION TABLE TO BUFFER MEMORY
S21
ACQUIRE UNUSED ADDRESS PA2 FROM UNUSED ADDRESS DISTINGUISHING TABLE BY USING RANDOM NUMBER GENERATING PROGRAM
S22
IS THERE OPERATION REQUEST FROM HOST ?
YES
S23
NO
ACQUIRE ADDRESS PA1 WHERE WRITE IS INFREQUENT
S25
ACQUIRE UNUSED ADDRESS (PA2) AND REWRITE DATA TO ADDRESS PA1 WHERE WRITE IS INFREQUENT
S26
REVISE UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA2: UNUSED ADDRESS → USED ADDRESS)
S27
S24
EXECUTE OPERATION REQUEST FROM HOST
REVISE USED ADDRESS REGISTRATION TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (RELEASE PA1 FROM REGISTRATION, AND REGISTER PA2 FOR USE)
S28
REVISE UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA1: USED ADDRESS → UNUSED ADDRESS)
S29
END

FIG. 9

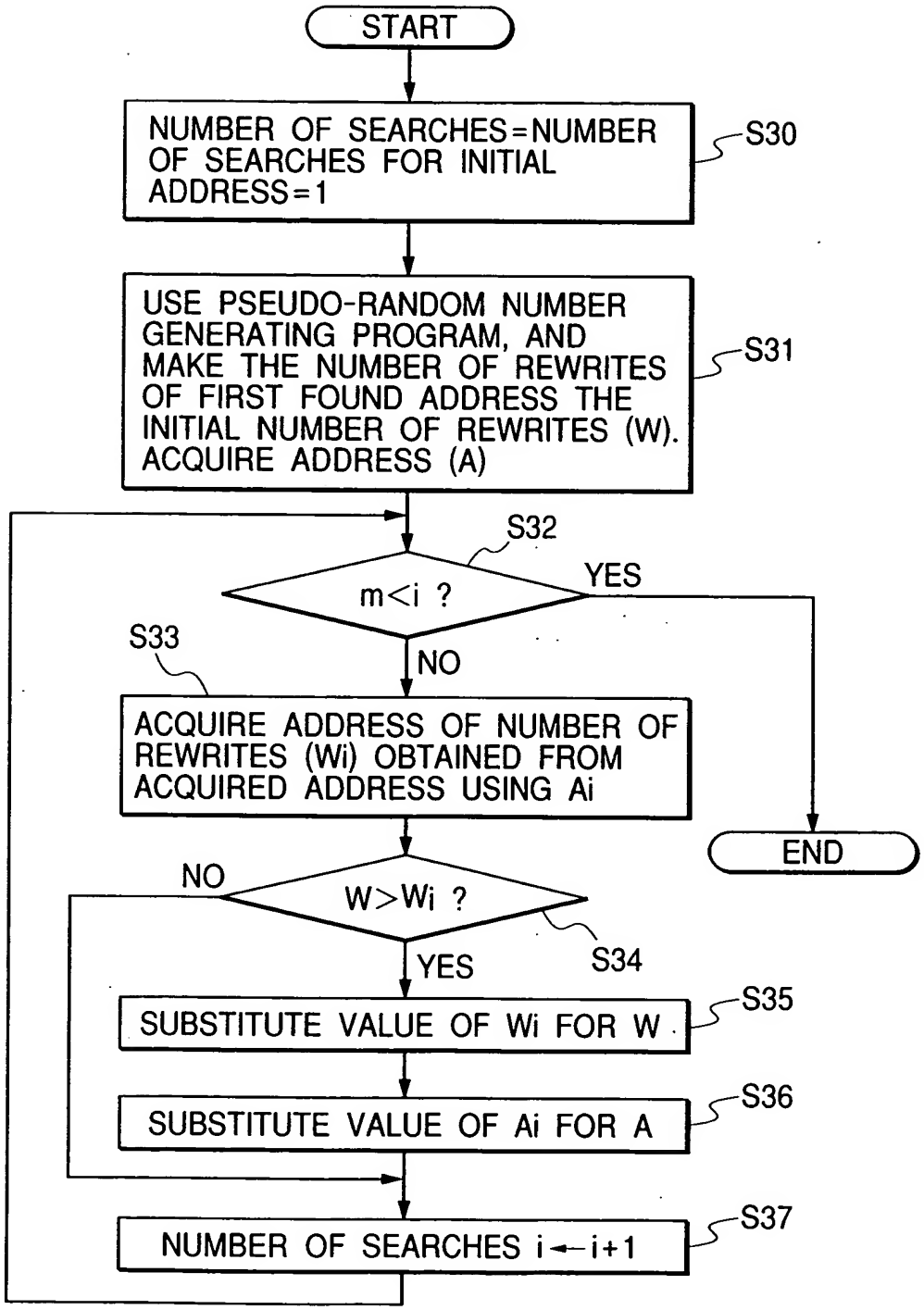

START
NUMBER OF SEARCHES=NUMBER OF SEARCHES FOR INITIAL ADDRESS=1
S30
USE PSEUDO-RANDOM NUMBER GENERATING PROGRAM, AND MAKE THE NUMBER OF REWRITES OF FIRST FOUND ADDRESS THE INITIAL NUMBER OF REWRITES (W). ACQUIRE ADDRESS (A)
S31
S32
m<i ?
YES
NO
S33
ACQUIRE ADDRESS OF NUMBER OF REWRITES (Wi) OBTAINED FROM ACQUIRED ADDRESS USING Ai
END
NO
W>Wi ?
YES
S34
SUBSTITUTE VALUE OF Wi FOR W
S35
SUBSTITUTE VALUE OF Ai FOR A
S36
NUMBER OF SEARCHES i←i+1
S37

FIG. 10

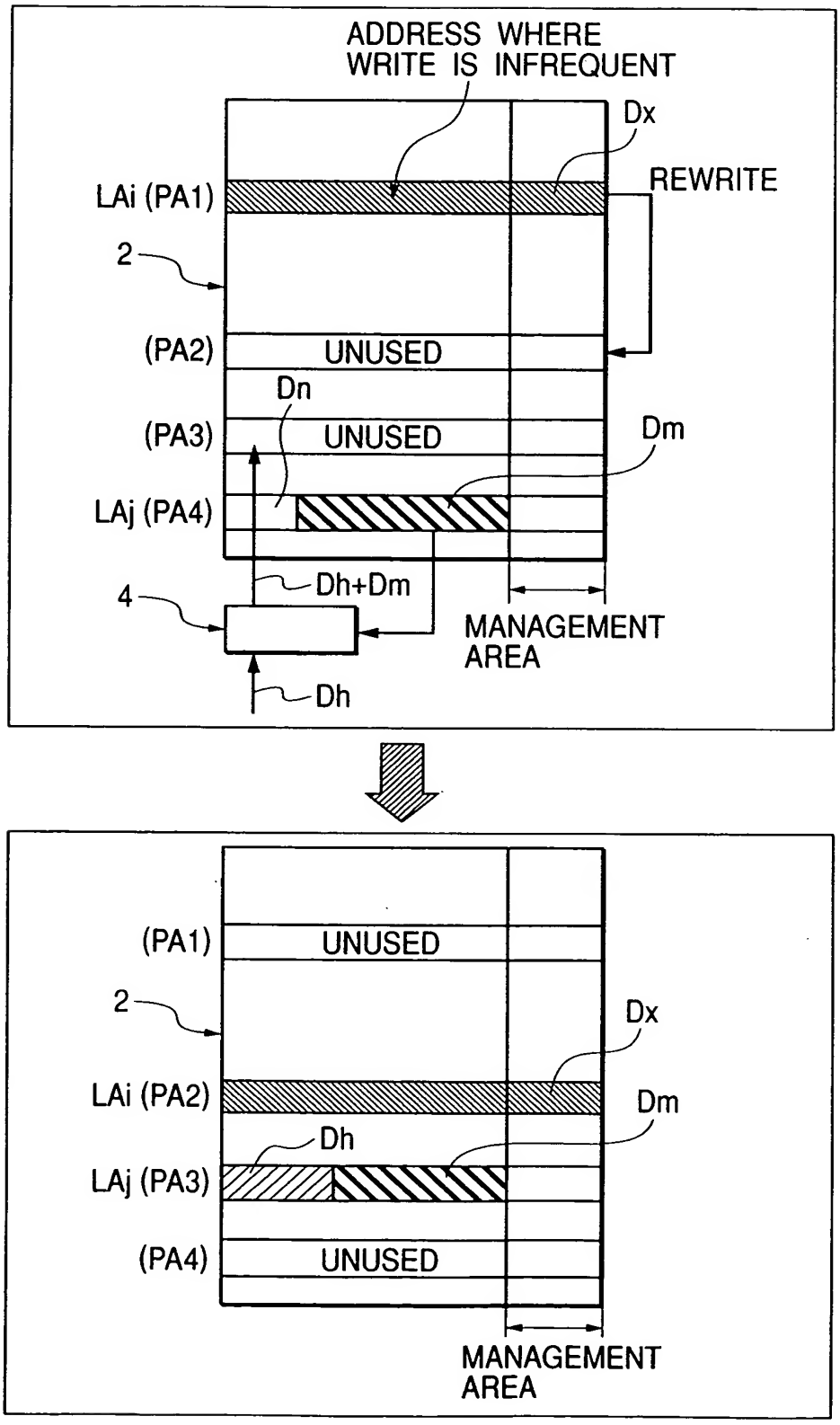

ADDRESS WHERE
WRITE IS INFREQUENT
Dx
REWRITE
LAi (PA1)
2
(PA2)
UNUSED
Dn
(PA3)
UNUSED
Dm
LAj (PA4)
Dh+Dm
4
MANAGEMENT
AREA
Dh
(PA1)
UNUSED
2
Dx
LAi (PA2)
Dm
Dh
LAj (PA3)
(PA4)
UNUSED
MANAGEMENT
AREA

FIG. 11

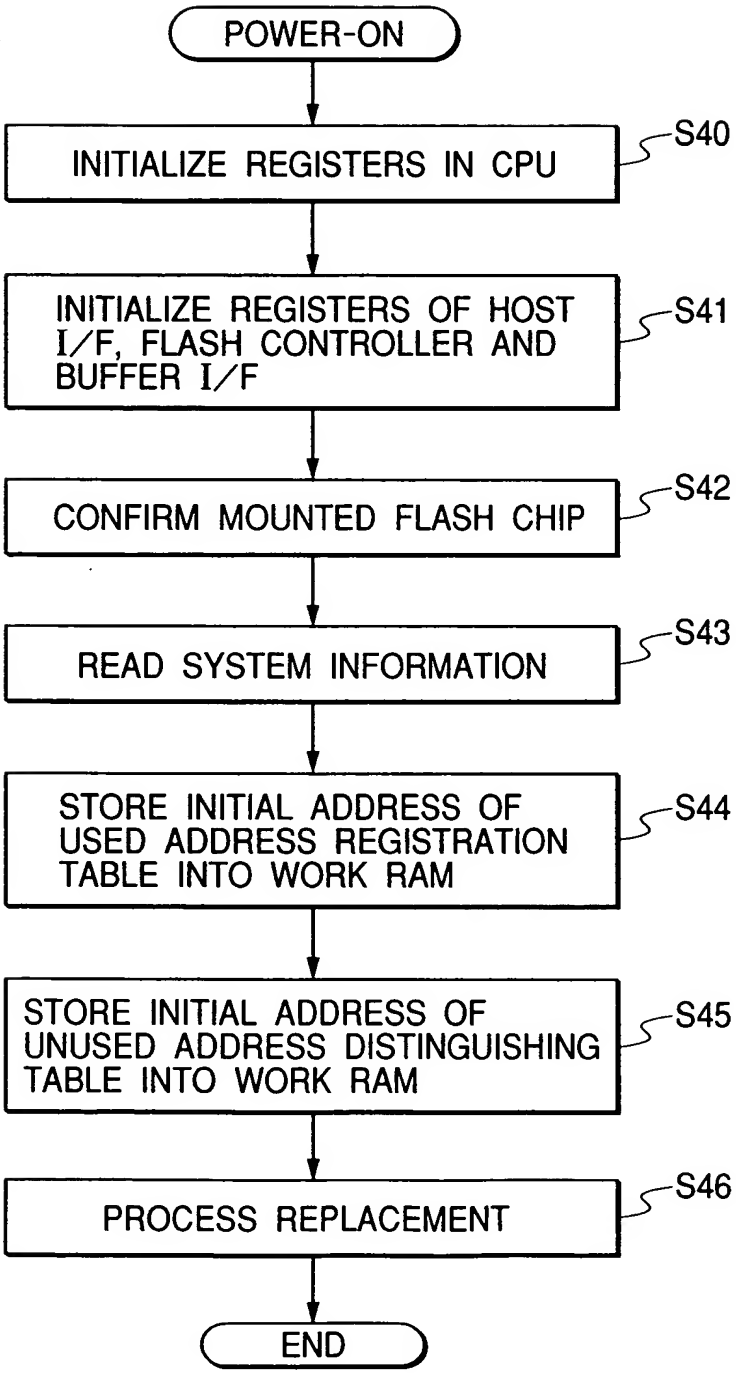

POWER-ON
INITIALIZE REGISTERS IN CPU
S40
INITIALIZE REGISTERS OF HOST I/F, FLASH CONTROLLER AND BUFFER I/F
S41
CONFIRM MOUNTED FLASH CHIP
S42
READ SYSTEM INFORMATION
S43
STORE INITIAL ADDRESS OF USED ADDRESS REGISTRATION TABLE INTO WORK RAM
S44
STORE INITIAL ADDRESS OF UNUSED ADDRESS DISTINGUISHING TABLE INTO WORK RAM
S45
PROCESS REPLACEMENT
S46
END

FIG. 12

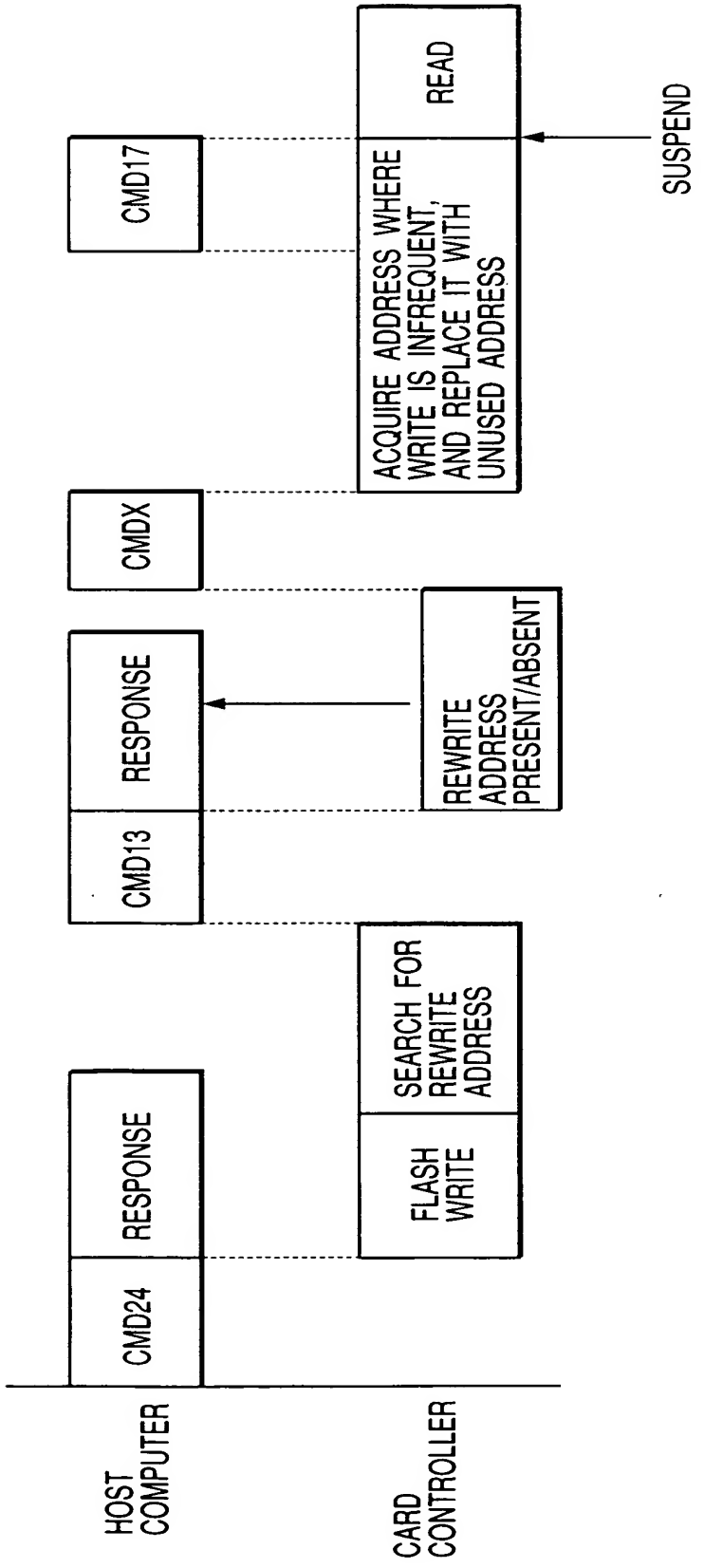

HOST COMPUTER
CARD CONTROLLER
CMD24
RESPONSE
FLASH WRITE
SEARCH FOR REWRITE ADDRESS
CMD13
RESPONSE
REWRITE ADDRESS PRESENT/ABSENT
CMDX
ACQUIRE ADDRESS WHERE WRITE IS INFREQUENT, AND REPLACE IT WITH UNUSED ADDRESS
CMD17
READ
SUSPEND

FIG. 13

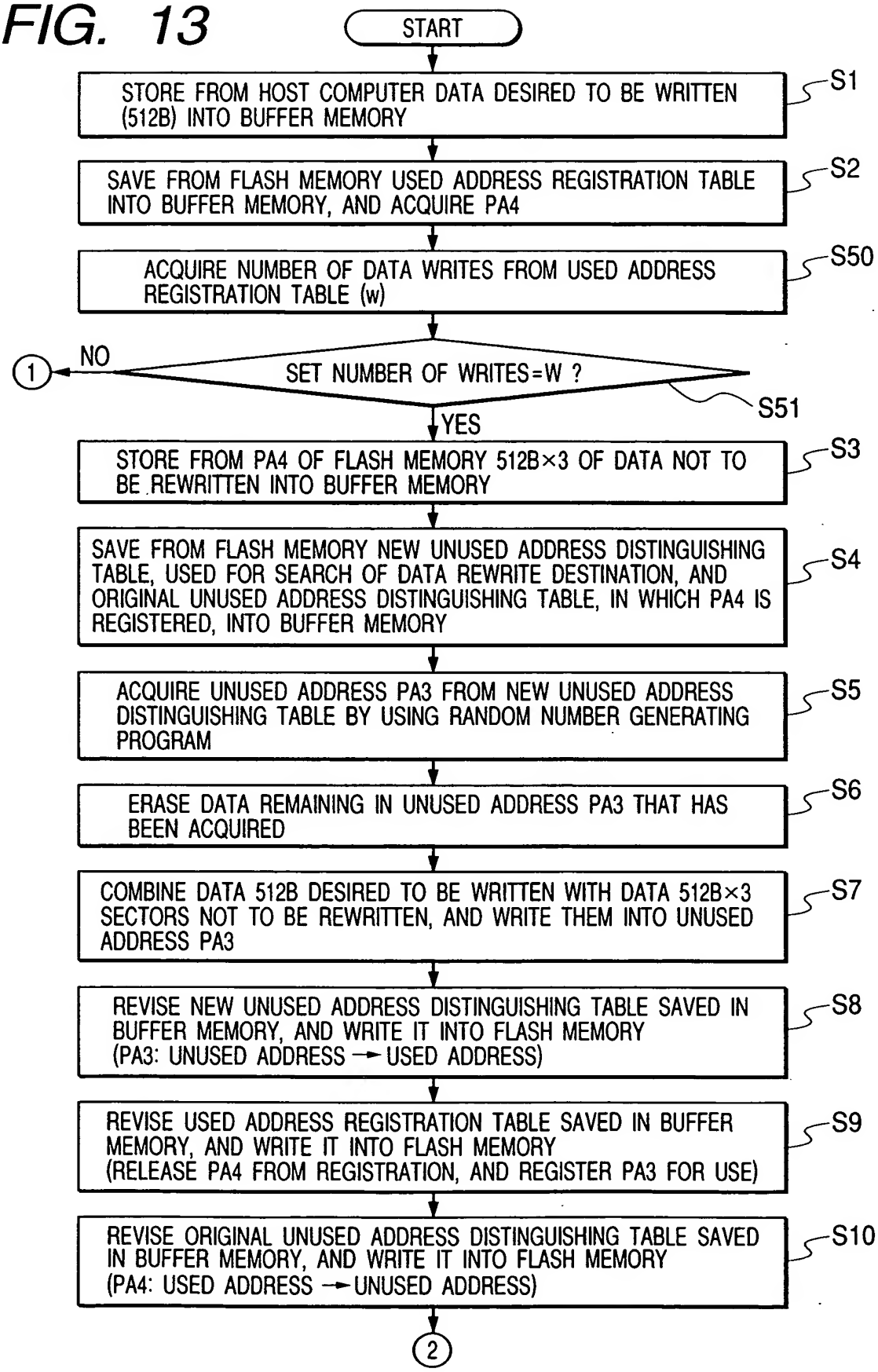

START
STORE FROM HOST COMPUTER DATA DESIRED TO BE WRITTEN (512B) INTO BUFFER MEMORY
S1
SAVE FROM FLASH MEMORY USED ADDRESS REGISTRATION TABLE INTO BUFFER MEMORY, AND ACQUIRE PA4
S2
ACQUIRE NUMBER OF DATA WRITES FROM USED ADDRESS REGISTRATION TABLE (w)
S50
SET NUMBER OF WRITES=W ?
S51
NO
1
YES
STORE FROM PA4 OF FLASH MEMORY 512B×3 OF DATA NOT TO BE REWRITTEN INTO BUFFER MEMORY
S3
SAVE FROM FLASH MEMORY NEW UNUSED ADDRESS DISTINGUISHING TABLE, USED FOR SEARCH OF DATA REWRITE DESTINATION, AND ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE, IN WHICH PA4 IS REGISTERED, INTO BUFFER MEMORY
S4
ACQUIRE UNUSED ADDRESS PA3 FROM NEW UNUSED ADDRESS DISTINGUISHING TABLE BY USING RANDOM NUMBER GENERATING PROGRAM
S5
ERASE DATA REMAINING IN UNUSED ADDRESS PA3 THAT HAS BEEN ACQUIRED
S6
COMBINE DATA 512B DESIRED TO BE WRITTEN WITH DATA 512B×3 SECTORS NOT TO BE REWRITTEN, AND WRITE THEM INTO UNUSED ADDRESS PA3
S7
REVISE NEW UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA3: UNUSED ADDRESS → USED ADDRESS)
S8
REVISE USED ADDRESS REGISTRATION TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (RELEASE PA4 FROM REGISTRATION, AND REGISTER PA3 FOR USE)
S9
REVISE ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA4: USED ADDRESS → UNUSED ADDRESS)
S10
2

FIG. 14

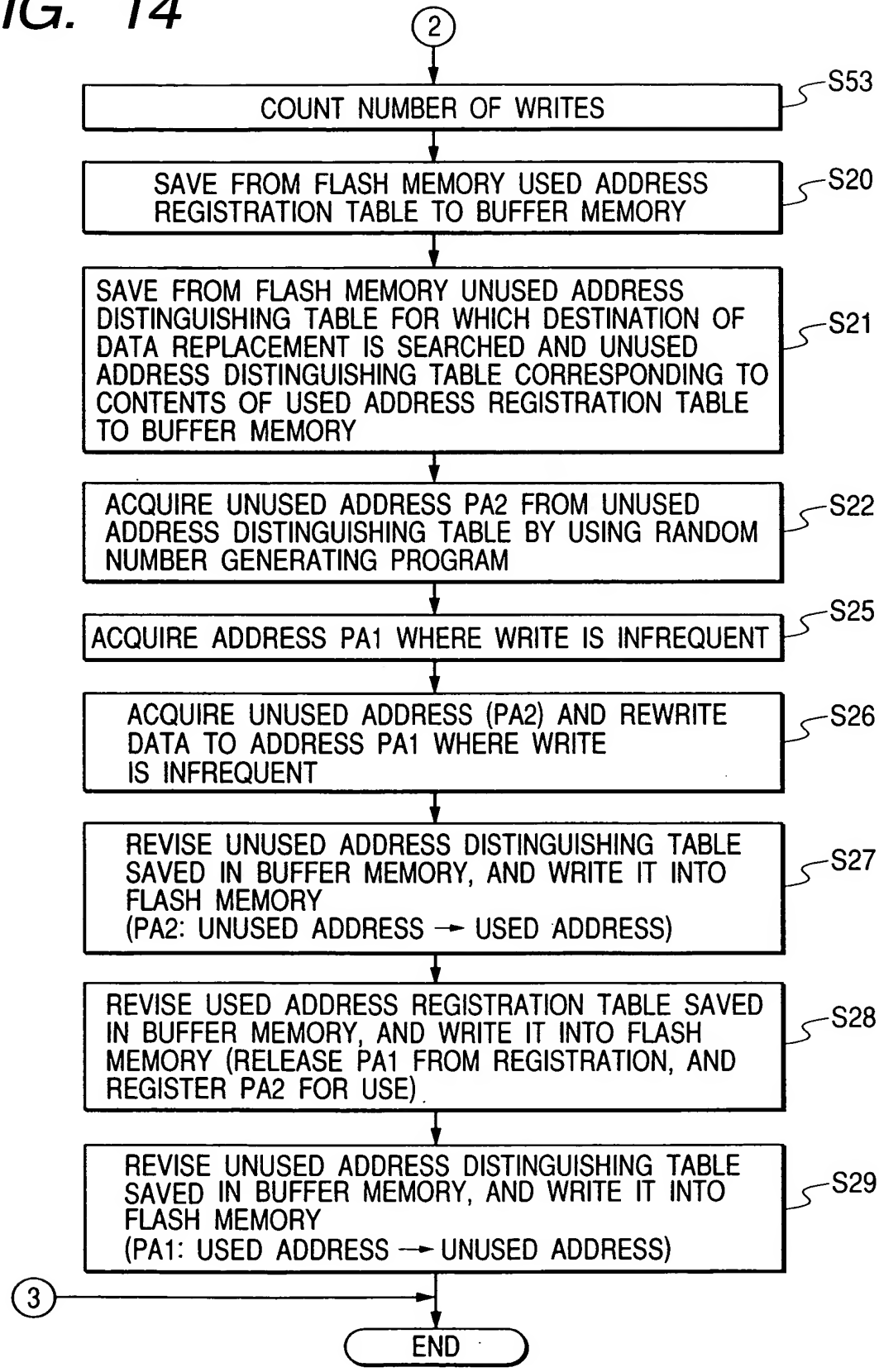

2
COUNT NUMBER OF WRITES
S53
SAVE FROM FLASH MEMORY USED ADDRESS REGISTRATION TABLE TO BUFFER MEMORY
S20
SAVE FROM FLASH MEMORY UNUSED ADDRESS DISTINGUISHING TABLE FOR WHICH DESTINATION OF DATA REPLACEMENT IS SEARCHED AND UNUSED ADDRESS DISTINGUISHING TABLE CORRESPONDING TO CONTENTS OF USED ADDRESS REGISTRATION TABLE TO BUFFER MEMORY
S21
ACQUIRE UNUSED ADDRESS PA2 FROM UNUSED ADDRESS DISTINGUISHING TABLE BY USING RANDOM NUMBER GENERATING PROGRAM
S22
ACQUIRE ADDRESS PA1 WHERE WRITE IS INFREQUENT
S25
ACQUIRE UNUSED ADDRESS (PA2) AND REWRITE DATA TO ADDRESS PA1 WHERE WRITE IS INFREQUENT
S26
REVISE UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY
(PA2: UNUSED ADDRESS → USED ADDRESS)
S27
REVISE USED ADDRESS REGISTRATION TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (RELEASE PA1 FROM REGISTRATION, AND REGISTER PA2 FOR USE)
S28
REVISE UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY
(PA1: USED ADDRESS → UNUSED ADDRESS)
S29
3
END

FIG. 15

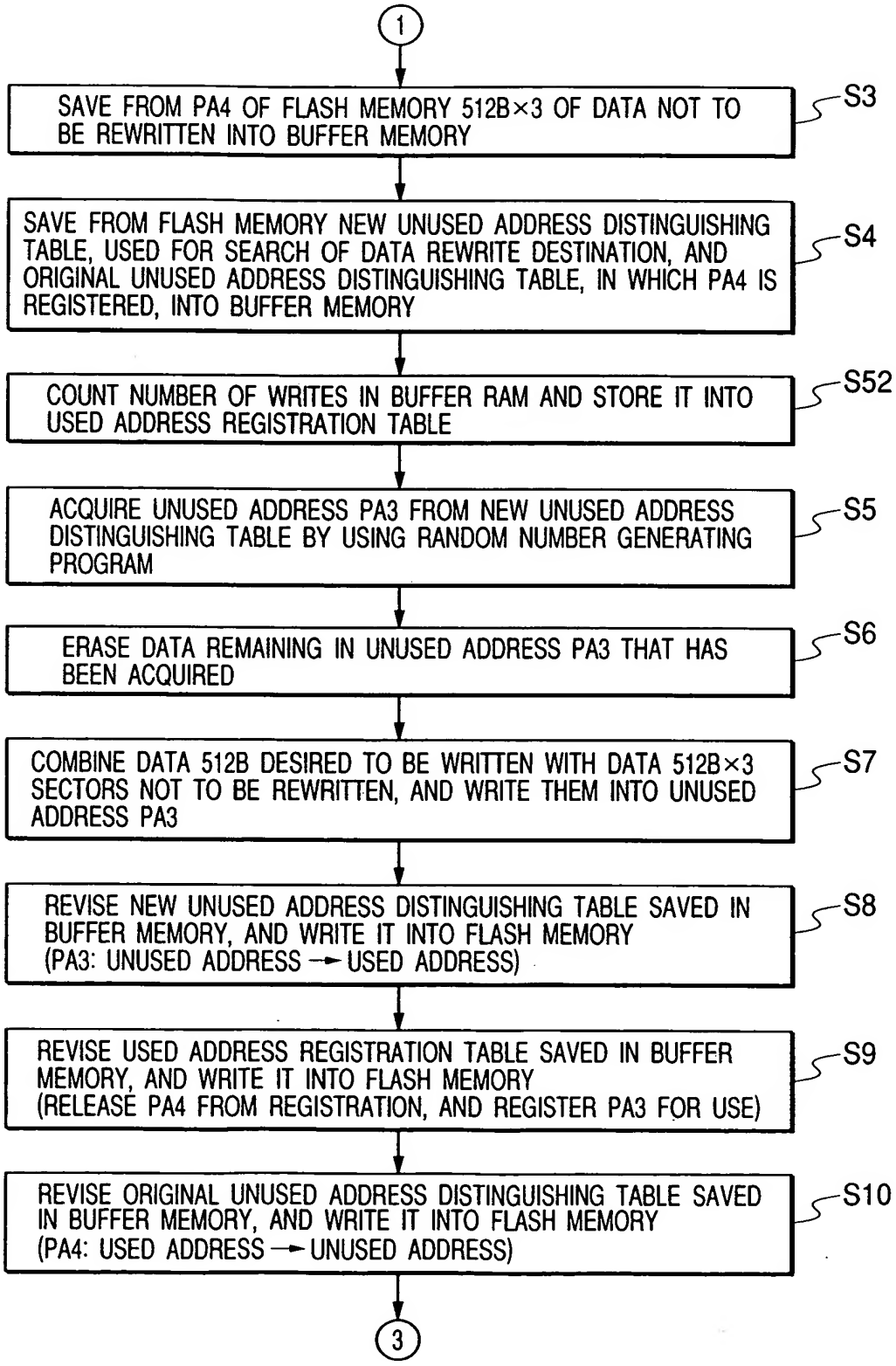
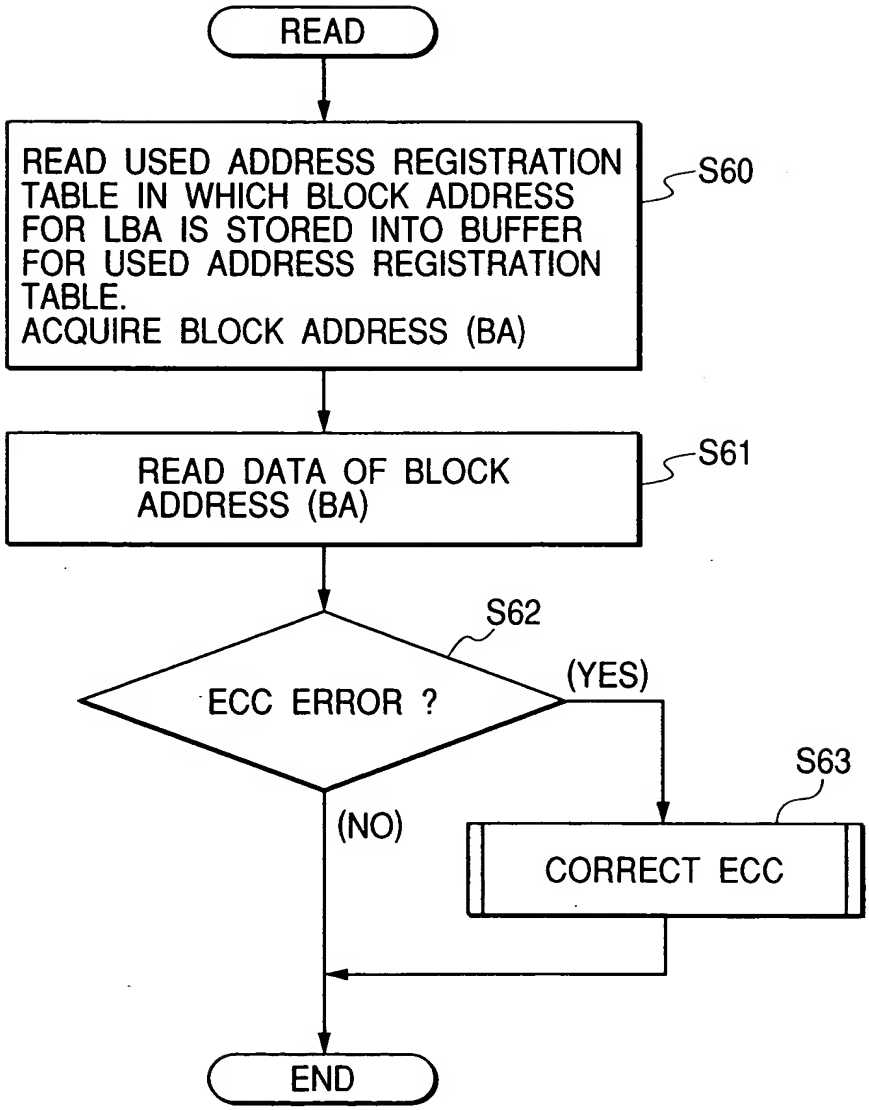

1
SAVE FROM PA4 OF FLASH MEMORY 512B×3 OF DATA NOT TO BE REWRITTEN INTO BUFFER MEMORY
S3
SAVE FROM FLASH MEMORY NEW UNUSED ADDRESS DISTINGUISHING TABLE, USED FOR SEARCH OF DATA REWRITE DESTINATION, AND ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE, IN WHICH PA4 IS REGISTERED, INTO BUFFER MEMORY
S4
COUNT NUMBER OF WRITES IN BUFFER RAM AND STORE IT INTO USED ADDRESS REGISTRATION TABLE
S52
ACQUIRE UNUSED ADDRESS PA3 FROM NEW UNUSED ADDRESS DISTINGUISHING TABLE BY USING RANDOM NUMBER GENERATING PROGRAM
S5
ERASE DATA REMAINING IN UNUSED ADDRESS PA3 THAT HAS BEEN ACQUIRED
S6
COMBINE DATA 512B DESIRED TO BE WRITTEN WITH DATA 512B×3 SECTORS NOT TO BE REWRITTEN, AND WRITE THEM INTO UNUSED ADDRESS PA3
S7
REVISE NEW UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA3: UNUSED ADDRESS → USED ADDRESS)
S8
REVISE USED ADDRESS REGISTRATION TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (RELEASE PA4 FROM REGISTRATION, AND REGISTER PA3 FOR USE)
S9
REVISE ORIGINAL UNUSED ADDRESS DISTINGUISHING TABLE SAVED IN BUFFER MEMORY, AND WRITE IT INTO FLASH MEMORY (PA4: USED ADDRESS → UNUSED ADDRESS)
S10
3

FIG. 16


READ
READ USED ADDRESS REGISTRATION TABLE IN WHICH BLOCK ADDRESS FOR LBA IS STORED INTO BUFFER FOR USED ADDRESS REGISTRATION TABLE.
ACQUIRE BLOCK ADDRESS (BA)
S60
READ DATA OF BLOCK ADDRESS (BA)
S61
S62
ECC ERROR ?
(YES)
(NO)
S63
CORRECT ECC
END